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(54) METHOD FOR PRODUCTION OF A MULTI-PLY PAPERBOARD

(57) There is provided a method of forming a multi-ply paperboard comprising at least a first ply and a second ply in a full-scale paperboard machine, wherein the method comprises the following steps:
- forming a first ply web and a second ply web in a wire section of the paperboard machine;
- spraying water substantially free from bonding chemicals onto a surface of the first ply web or second ply web to obtain a wetted surface in the wire section; and
- merging the wetted surface with a surface of the other web by couching.

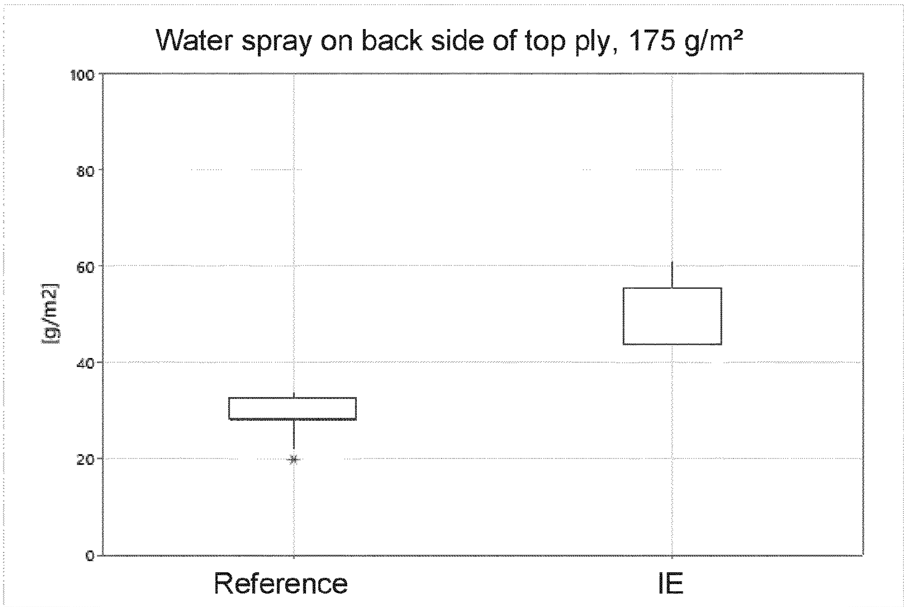

Fig. 1

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Description

TECHNICAL FIELD

[0001] The present disclosure relates to the field of production of multi-ply paperboards.

BACKGROUND

[0002] Paperboards are commonly made of one ply or out of two or more plies, wherein the latter is referred to as multi-plied paperboards. Multi-plied paperboards are used in for example packaging due to their mechanical properties.
[0003] The mechanical properties including the bond strength between the plies is an important feature for multi-ply boards.
[0004] Apart from mechanical properties, optimization of the production process of the multi-plied paperboard is also important.

SUMMARY

[0005] One objective is to make available a method which provides a multi-plied paperboard of high strength with a decreased cost in a full-scale paperboard machine.
[0006] Accordingly, the present disclosure provides a method of forming a multi-ply paperboard comprising at least a first ply and a second ply in a full-scale paperboard machine, wherein the method comprises the following steps:

- forming a first ply web and a second ply web in a wire section of the paperboard machine;
- spraying water substantially free from bonding chemicals onto a surface of the first ply web or second ply web to obtain a wetted surface in the wire section; and
- merging the wetted surface with a surface of the other web by couching.

BRIEF DESCRIPTION OF THE DRAWINGS

[0007]

Fig. 1 shows box plots of the amount of sprayed water on the back side of the top ply prior to couching with the middle ply of the reference as well as the inventive example (IE) for paperboards with a final grammage of about 175 g/m^2.

Fig. 2 shows box plots of the amount of sprayed water on the back side of the top ply prior to couching with the middle ply of the reference as well as the inventive example (IE) for paperboards with a final grammage of about 248 g/m^2.

Fig. 3 shows box plots of the amount of sprayed water on the top side of the back ply prior to couching with the middle ply of the reference as well as the inventive example (IE) for paperboards with a final grammage of about 175 g/m^2.

Fig. 4 shows box plots of the amount of sprayed water on the top side of the back ply prior to couching with the middle ply of the reference as well as the inventive example (IE) for paperboards with a final grammage of about 248 g/m^2.

Fig. 5 shows box plots of the internal bond strength, Scott Bond, of paperboards produced as reference as well as inventive example (IE) for paperboards with a final grammage of about 175 g/m^2.

Fig. 6 shows box plots of the internal bond strength, Scott Bond, of paperboards produced as reference as well as inventive example (IE) for paperboards with a final grammage of about 248 g/m^2.

Fig. 7 shows box plots of the z-directional tensile strength, of paperboards produced as reference as well as inventive example (IE) for paperboards with a final grammage of about 175 g/m^2.

Fig. 8 shows box plots of the z-directional tensile strength, of paperboards produced as reference as well as inventive example (IE) for paperboards with a final grammage of about 248 g/m^2.

DETAILED DESCRIPTION

[0008] The present disclosure provides a method of forming a multi-ply paperboard comprising at least a first ply and a second ply in a full-scale paperboard machine, wherein the method comprises the following steps:

- forming a first ply web and a second ply web in a wire section of the paperboard machine;
- spraying water substantially free from bonding chemicals onto a surface of the first ply web or second ply web to obtain a wetted surface in the wire section; and
- merging the wetted surface with a surface of the other web by couching.

[0009] As understood by the skilled person, the first ply web forms the first ply and the second ply web forms the second ply in the multi-ply paperboard.

[0010] The first ply web and second ply web are formed in the wire section of the paperboard machine. The webs are thereby provided on individual forming wires from individual headboxes.

[0011] A full-scale paperboard machine comprises a machine chest, an approach flow system, at least one headbox, a wire section, press section, dryer section, a calender and a pope reeler. A paperboard machine used within the present disclosure comprises at least two headboxes. The wire section can contain one or several forming wires. In the present disclosure, where there are more than one headbox, there are several forming wires; one headbox per forming wire. In the forming section the forming wire is the auxiliary means of filtration when the furnish is dewatered, resulting in a wet web largely showing the surface characteristics of the wire. In the press section this formed web is mechanically dewatered under pressure. A full-scale paperboard machine operates at a wire speed of several hundreds of meters per minute, such as at least 400 m/min.

[0012] The water is substantially free of bonding chemicals. Particularly, the water is preferably free of at least the bonding chemicals starch, microfibrillated cellulose (MFC) and carboxymethyl cellulose (CMC). By bonding chemicals is meant substances that improves the ply-bond strength in a multi-ply paperboard. For the avoidance of doubt, this does not include starch added to any of the furnishes upstream the headboxes, i.e. to the furnishes. The strength of the plies may be further improved by addition of starch to the furnishes. Starch is preferably added in an amount of 1.5-7.0 kg/tonne based on dry weight of the furnishes, such as 2.0-6.0 kg/tonne based on dry weight of the furnishes.

[0013] The water is typically sprayed in an amount of at least 35 g/m^2 onto a surface of the first ply web or second ply web to obtain a wetted surface in the wire section. The amount of sprayed water may be even higher, such as at least 40 g/m^2, such as at least 45 g/m^2. As understood by the skilled person, the water is sprayed evenly over the surface of the first ply web or second ply web. One way of spraying the water evenly is to use nozzles from Spraying Systems AB of model H-U-9515.

[0014] Typically, the first ply web and the second ply web are dewatered to a dry content of below 30 % prior to the spraying of water. For example, by passing the webs over suction boxes to be partially dewatered. The inventors have realized that it is enough with application of water in an amount according to the present disclosure on the first ply web or second ply web also if the plies have been partially dewatered to provide satisfactory mechanical properties in the z-direction. Thereby, a facilitated process is provided since suction boxes are typically arranged in a position downstream of the headbox in a full-scale board machine and to provide a homogenous moisture content of the webs these has to be disconnected or turned off, which in turn would cause issues with for example dewatering downstream in the production process.

[0015] The wetted surface is merged with a surface of the other web by couching. Couching is a process well-known to the skilled person in which the webs are pressed together prior to final drying to adhere one another. The couching is typically conducted at a temperature of below 50 °C, such as below 40 °C. Accordingly, the couching is not the same principle as heat pressing, and it is advantageous of such process in terms of energy efficiency. The inventors have realized that there is no need to supply external heat to bind the wetted surface to the other web by the spraying of the water.

[0016] It is important that the different plies adhere so that the mechanical properties, in particular in the z-direction, are satisfactory. Moreover, if the adhesion between the plies, i.e. the ply-bond strength, is unsatisfactory, it may also cause the outer plies to at least partially lift from the middle pl(y/ies) which give rise to surface defects amongst other drawbacks.

[0017] Typically, when the water is applied on the surface of the first ply web or second ply web to obtain the wetted surface in the wire section the moisture content of web with the wetted surface is increased by 0.5-2.0 %. Moisture content of the webs can be measured online by for example a near-IR (NIR) sensor. The increase in moisture is measured by measuring the moisture before and after the spraying of water.

[0018] The first ply web may comprise chemical pulp. A preferred type of chemical pulp is kraft pulp, such as softwood kraft pulp. Typically, the proportion of chemical pulp in the first ply web is 15-80% by dry weight, such as 15-50% by dry weight. Inclusion of kraft pulp in the first ply web is beneficial in terms of strength properties.

[0019] The first ply web may comprise chemithermomechanical pulp (CTMP). CTMP is a bulky mechanical pulp. The CTMP may be bleached or unbleached. Even though the CTMP is a relatively weak type of pulp, the inclusion of chemical pulp balances the strength as the chemical pulp is a relatively strong type of pulp. Hence, it is preferred that if the first ply web comprises CTMP, the first ply web also comprises chemical pulp. It is beneficial to include CTMP in the first ply web as it decreases the density, i.e. increases the bulk, of the paperboard. A high bulk is preferred as less fibres are used per gram of paperboard. Within the content of the present disclosure, CTMP also includes high-temperature chemithermomechanical pulp (HT-CTMP). When producing HT-CTMP a higher preheating temperature, typically above 150 °C, is used to produce the pulp. In embodiments wherein the first ply web comprises chemithermomechanical pulp (CTMP), the CTMP is provided in a proportion of 0-45% by dry weight, such as 0-40% by dry weight. When the first ply web comprises CTMP, the first ply web typically forms a middle ply in the multi-ply paperboard. In such case, the second ply web typically forms a top ply in the multi-ply paperboard.

[0020] Surprisingly, the inventors realized that if water substantially free from bonding chemicals according to the present disclosure is sprayed, the mechanical properties in z-direction, e.g. said ZD tensile strength and Scott Bond, are provided at least of a similar level as when a regular amount of ply-bond starch is applied between the plies, which typically is higher, e.g. about 1 g/m^2 or more.

[0021] Moreover, the inventors have realized that when measuring the z-directional property Scott Bond value of multi-plied paperboards having at least three plies, the failure typically occurs in or near the interface of the top ply and the middle ply or in or near the interface of the back ply and the middle ply. In case the failure typically occurs in or near the interface of the top ply and the middle ply, the conclusion was made that there is a higher importance to provide a strong interface between the top ply and middle ply to provide a multi-plied paperboard having good z-direction (ZD) tensile strength as well as Scott Bond values. This was the case for the multi-plied paperboards produced on the paperboard machine used in the experimental section of the present disclosure.

[0022] The internal bond strength, Scott Bond, according to Tappi T 569, of the multi-plied paperboard is typically at least 175 J/m^2, such as at least 190 J/m^2. The z-directional (ZD) tensile strength according to Tappi T 541 of the multi-plied paperboard is typically at least 230 kPa, such as at least 300 kPa, such as at least 330 kPa.

[0023] A third ply web may be further formed in the wire section of the paperboard machine, and wherein said third ply web forms a back ply in the multi-ply paperboard. That is, in such case the first ply forms a middle ply and the second ply forms a top ply. Water free from bonding chemicals is typically also sprayed on a non-wetted surface of the second ply web or third ply web to obtain a second wetted surface in the wire section and merge the second wetted surface with a non-wetted surface of the second ply web or third ply web by couching. The amount of sprayed is typically at least 35 g/m^2. The amount of water may be even higher, such as at least 40 g/m^2, such as at least 45 g/m^2. Typically, the same amount of water is in such case sprayed on the non-wetted surface of the second ply web or third ply web as on the surface of the first ply web or second ply web.

[0024] Broke pulp is formed from trimmings and/or produced, but damaged (or otherwise wasted), board. The first ply web may comprise broke pulp. In such case, the proportion of broke pulp in the first ply furnish is typically 20-60% by dry weight, such as 25-50% by dry weight. A suitable Schopper-Riegler (SR) number for the broke pulp is °20-°40, such as °22-°38. Such a SR number may be obtained by adapting the degree of refining of the broke pulp. The SR number is measured according to ISO 5267-1:1999. Typically, the broke pulp in the first ply furnish has been refined with 15-50 kWh/t to provide the particular SR number. The broke pulp is typically obtained from the method of the present disclosure, which means that it has the same fibre composition as the multi-plied paperboard.

[0025] The density according to ISO 534:2011 of the multi-ply paperboard is typically 680-820 kg/m^3, such as 690-810 kg/m^3, such as 690-780 kg/m^3.

[0026] The grammage according to ISO 536:2020 of the multi-ply paperboard is typically 130-500 g/m^2, such as 150-480 g/m^2.

[0027] The thickness according to ISO 534:2011 of the multi-ply paperboard is typically 220-800 μm, such as 250-750 μm.

[0028] The method may comprise the step of coating the multi-ply paperboard with at least one coating ply. The at least one coating ply is typically coated on the top ply of the multi-ply paperboard forming the print side of the paperboard. The at least one coating ply is typically pigment-based. The total coat weight (dry) may be 12-30 g/m^2. The top ply may be coated with more than one coating, such as a dual-ply coating or triple-ply coating. Suitable pigments are clay and/or calcium carbonate and/or talc. In case of a dual-ply coating, drying between the application of a first coating ply and the application of a second coating ply can be conducted. For the single ply coating, drying is conducted after coating. Drying is typically performed with non-contact drying, such as IR and/or hot air, or contact drying, such as with drying cylinder(s), or a combination of non-contact and contact drying. The present disclosure is not limited to any particular coating technique and several different types of techniques, can thus be used. The techniques include: blade coating, rod coating, air-knife coating, rotogravure coating and/or curtain coating. All coatings may be applied in-line (also referred to as on-line). In such case, the productivity is increased by eliminating the handling operations linked to off-line treatment and by eliminating, or at least reducing, the amount of waste. Alternatively, the coatings may also be applied off-line.

[0029] The multilayer paperboard can for example be used as a containerboard, such as linerboard, or a cartonboard, such as a liquid packaging board (LPB).

EXAMPLES

Manufacturing of a 3-ply paperboard with varied amount of sprayed water

[0030] In a full-scale paperboard machine, a 3-ply paperboard was produced from a top ply furnish, a middle ply furnish and a back ply furnish. This composition of the paperboard is referred to as "Paperboard 1". Paperboard 1 was produced in two different baseboard grammages: 175 g/m^2 ("Paperboard 1a") and 248 g/m^2 ("Paperboard 1b"). The paperboards were thereafter coated with a coat weight of 19 g/m^2.

[0031] The furnishes contained softwood kraft pulp (SW kraft), hardwood kraft pulp (HW kraft), chemithermomechanical pulp (CTMP) and broke pulp as presented in Table 1 below.

Table 1. Composition of each ply in Paperboard 1.

Paperboard	Paperboard grammage	Top ply composition (% by dry weight)	Middle ply composition (% by dry weight)	Back ply composition (% by dry weight)
1a	175 g/m^2	65% SW kraft/ 35% HW kraft	30% SW kraft/ 30% CTMP/ 34% broke pulp	100 % SW kraft
1b	248 g/m^2	65% SW kraft/ 35% HW kraft	31% SW kraft/ 34% CTMP/ 35% broke pulp	100 % SW kraft

[0032] The top ply furnish, middle ply furnish and back ply furnish were each provided from separate headboxes on separate forming wires to provide a top ply web, a middle ply web and a back ply web. On the back side of the top ply web that is to be in contact with the middle ply web, water was sprayed. Thereafter, the top ply web and middle ply web were combined by couching.

[0033] The amount of sprayed water was varied from about 25 g/m^2 (Reference) to about 45 g/m^2 (Inventive Example (IE)) for paperboard 1a with a grammage of 175 g/m^2 and from about 25 g/m^2 (Reference) to about 65 g/m^2 (Inventive Example (IE)) for paperboard 1b with a grammage of 248 g/m^2. The composition of the plies of the paperboards was unchanged between the references and inventive examples for each of the grammages.

[0034] The sprayed water on the back side of the top ply web is presented in Figs. 1 & 2. In Fig. 1 the sprayed water on the back side of the top ply in paperboard 1a is presented and in Fig. 2 the sprayed water on the back side of the top ply in paperboard 1b is presented.

[0035] When the amount of sprayed water was 25 g/m^2, the amount of starch sprayed was about 1 g/m^2 (Reference) and with the higher amount of sprayed water, the amount of starch was decreased to 0 g/m^2 (Inventive Example (IE)). As a consequence of that no starch was added to the water dispersion, the amount of water was increased. This is since the total flow remained the same, but no starch was occupying part of the flow.

[0036] Moreover, on top side of the back ply web that is to be in contact with the middle ply web, water was also sprayed. Thereafter, the back ply web and middle ply web that had previously been couched with the top ply web were combined by couching.

[0037] The amount of sprayed water was kept constant at about 25 g/m^2 (Reference; IE) for paperboard 1a and varied from about 25 g/m^2 (Reference) to about 40 g/m^2 (Inventive Example (IE)) for paperboard 1b (Inventive Example (IE)). The sprayed water on the top side of the back ply web is presented in Figs. 3 & 4. In Fig. 3 the sprayed water on the top side of the back ply in paperboard 1a is presented and in Fig. 4 the sprayed water on the top side of the back ply in paperboard 1b is presented.

[0038] In Fig. 5 the Scott Bond value measured according to TAPPI T 569 are presented for paperboard 1a. As laid out above, in the reference, about 25 g/m^2 of water and about 1 g/m^2 of starch was sprayed on the back side of the top ply. In the inventive example (IE), about 45 g/m^2 of water and 0 g/m^2 of starch was sprayed on the back side of the top ply. In Fig. 6 the Scott Bond value measured according to TAPPI T 569 are presented for paperboard 1b. As laid out above, in the reference, about 25 g/m^2 of water and about 1 g/m^2 of starch was sprayed on the back side of the top ply. In the inventive example (IE), about 65 g/m^2 of water and 0 g/m^2 of starch was sprayed on the back side of the top ply.

[0039] Surprisingly, when the content of sprayed starch was decreased to 0 g/m^2, i.e. in the IEs, and the amount of sprayed water was increased, the Scott Bond values even increased. Spray starch is known to be used for ply-bond strength. The inventors thereby realized that if the sprayed water is increased, the sprayed starch can be omitted. The moisture content of the top ply web was measured on-line before and after spraying of the water being free of starch and the moisture content increased with about 1 % by the spraying of the starch-free water.

[0040] For the avoidance of doubt, no other bonding chemical was added to the water instead of the starch so when water with 0 g/m^2 of starch was sprayed it was only water being sprayed.

[0041] Moreover, in Fig. 7 the z-directional (ZD) tensile strength measured according to TAPPI T 541 are presented for the paperboard 1a and in Fig. 8 for paperboard 1b. Just as for Scott Bond values, the ZD tensile strength did not decrease by the reduction in sprayed starch. Instead, it was remained at about the same level as when the starch was sprayed.

Manufacturing of a 3-ply paperboard with varied content of CTMP and starch in the middle ply

[0042] In a full-scale paperboard machine, 3-ply paperboards were produced from a top ply furnish, a middle ply furnish and a back ply furnish. The compositions of the paperboards are referred to as "Paperboards 2-4". The range of grammages produced of the paperboards is presented in Table 2 below.

[0043] The furnishes contained softwood kraft pulp (SW kraft), hardwood kraft pulp (HW kraft), chemithermomechanical pulp (CTMP) and broke pulp as presented in Table 2 below.

Table 2. Composition of each ply in Paperboards 2-4.

Paperboard	Paperboard grammage	Top ply composition (% by dry weight)	Middle ply composition (% by dry weight)	Back ply composition (% by dry weight)
2	150-295 g/m2	65-75% HW kraft/25-35% SW kraft	15% SW kraft/ 40% CTMP/ 45% broke pulp	100% SW kraft
3	155-210 g/m2	70% HW kraft/ 30% SW kraft	0-10% SW kraft/ 45% CTMP/ 45-55% broke pulp	80% SW kraft/ 20% broke pulp
4	140-205 g/m2	25% SW kraft/ 75% HW kraft	55% CTMP/ 45% broke pulp	100 % SW kraft

[0044] All paperboards were produced with varied amount of sprayed starch or no starch at all as summarized in Table 3 below.

[0045] The amount of sprayed water was the same as for paperboard 1, i.e. for the reference the amount was about 25 g/m^2 and for the examples with reduced or no starch the amount was about 45 g/m^2 or 65 g/m^2 depending on paperboard grammage. Paperboards having lower grammages, around 175 g/m^2 were sprayed with 45 g/m^2 water, while paperboards having higher grammages, around 248 g/m^2 were sprayed with 65 g/m^2 water.

[0046] A summary of the amount of starch sprayed on the back side of the top ply web as well as on the top side of the back ply web is presented below in Table 3.

[0047] Mechanical properties in terms of z-directional properties measured by Scott Bond measured according to TAPPI T 569 and z-directional (ZD) tensile strength measured according to TAPPI T 541 were evaluated for these paperboards. A comparison was thereafter made to each individual reference for each paperboard where 25 g/m^2 water and 1 g/m^2 starch was sprayed on the back side of the top ply web.

Table 3. Starch addition and comparison of z-directional mechanical properties.

Paperboard	Starch addition on back side of the top ply web	Z-directional mechanical properties
2a	About 1 g/m^2	Reference
2b	About 0 g/m^2	About the same as the reference
3a	About 1 g/m^2	Reference
3b	Estimated possible starch addition: About 0.3 g/m^2	About the same as the reference*
3c	About 0 g/m^2	Estimated to be slightly lower than reference*
4a	About 1.0 g/m^2	Reference
4b	About 0 g/m^2	Not satisfactory
*Estimated based on that 55% CTMP (paperboard 4) provides unsatisfactory z-directional mechanical properties without starch and that 40% CTMP (paperboard 2) provides similar z-directional mechanical properties with and without sprayed starch.		

[0048] In conclusion of these tests, when a ply contains CTMP and the CTMP content is above 45%, at least some content of starch is needed to provide satisfactory z-directional mechanical properties.

Claims

1. A method of forming a multi-ply paperboard comprising at least a first ply and a second ply in a full-scale paperboard machine, wherein the method comprises the following steps:

   - forming a first ply web and a second ply web in a wire section of the paperboard machine;
   - spraying water substantially free from bonding chemicals onto a surface of the first ply web or second ply web to obtain a wetted surface in the wire section; and
   - merging the wetted surface with a surface of the other web by couching.

2. The method of claim 1, wherein the water is sprayed in an amount of at least 35 g/m^2, such as at least 40 g/m^2, such as at least 45 g/m^2 to obtain the wetted surface in the wire section.

3. The method of claim 1 or 2, wherein the water is substantially free of at least the bonding chemicals starch, microfibrillated cellulose (MFC) and carboxymethyl cellulose (CMC).

4. The method of any one of the preceding claims, wherein the couching is conducted at a temperature of below 50 °C, such as below 40 °C.

5. The method of any one of the preceding claims, wherein the moisture content of the web with the wetted surface is increased by 0.5-2.0 % by the spraying of water.

6. The method of any one of the preceding claims, wherein the first ply web and the second ply web are dewatered to a dry content of below 30 % prior to the spraying of water.

7. The method of any one of the preceding claims, wherein the first ply web comprises chemical pulp, such as kraft pulp, such as softwood kraft pulp.

8. The method of claim 7, wherein the proportion of chemical pulp in the first ply web is 15-80% by dry weight, such as 15-50% by dry weight.

9. The method of any one of the preceding claims, wherein the first ply web comprises chemithermomechanical pulp (CTMP) in a proportion of 0-45% by dry weight, such as 0-40% by dry weight.

10. The method of any one of claims 7-9, wherein the first ply web forms a middle ply in the multi-ply paperboard.

11. The method of claim 10, wherein the second ply web forms a top ply in the multi-ply paperboard.

12. The method of claim 10 or 11, wherein a third ply web is further formed in the wire section of the paperboard machine, and wherein said third ply web forms a back ply in the multi-ply paperboard.

13. The method of claim 12, wherein water substantially free from bonding chemicals is also sprayed on a non-wetted surface of the second ply web or third ply web to obtain a second wetted surface in the wire section and merge the second wetted surface with a non-wetted surface of the second ply web or third ply web by couching.

14. The method of any one of the preceding claims, wherein Scott Bond strength according to Tappi T 569, of the multi-plied paperboard is at least 175 J/m^2, such as at least 190 J/m^2.

15. The method of any one of the preceding claims, wherein z-directional (ZD) tensile strength according to Tappi T 541 of the multi-plied paperboard is at least 300 kPa, such as at least 330 kPa.

Amended claims in accordance with Rule 137(2) EPC.

1. A method of forming a multi-ply paperboard comprising at least a first ply and a second ply in a full-scale paperboard machine, wherein the method comprises the following steps:

- forming a first ply web and a second ply web in a wire section of the paperboard machine;
- spraying water substantially free from bonding chemicals onto a surface of the first ply web or second ply web to obtain a wetted surface in the wire section, wherein the water is sprayed in an amount of at least 35 g/m^2; and
- merging the wetted surface with a surface of the other web by couching,
- wherein the first ply web comprises chemithermomechanical pulp (CTMP) in a proportion of 0-45% by dry weight,
- wherein the first ply web comprises chemical pulp, and
- the grammage according to ISO 536:2020 of the multi-ply paperboard is 130-500 g/m^2.

2. The method of claim 1, wherein the water is sprayed in an amount of at least 40 g/m^2, such as at least 45 g/m^2 to obtain the wetted surface in the wire section.

3. The method of claim 1 or 2, wherein the water is substantially free of at least the bonding chemicals starch, microfibrillated cellulose (MFC) and carboxymethyl cellulose (CMC).

4. The method of any one of the preceding claims, wherein the couching is conducted at a temperature of below 50 °C, such as below 40 °C.

5. The method of any one of the preceding claims, wherein the moisture content of the web with the wetted surface is increased by 0.5-2.0 % by the spraying of water.

6. The method of any one of the preceding claims, wherein the first ply web and the second ply web are dewatered to a dry content of below 30 % prior to the spraying of water.

7. The method of any one of the preceding claims, wherein the first ply web comprises kraft pulp, such as softwood kraft pulp.

8. The method of claim 7, wherein the proportion of chemical pulp in the first ply web is 15-80% by dry weight, such as 15-50% by dry weight.

9. The method of any one of the preceding claims, wherein the first ply web comprises (CTMP) in a proportion of 0-40% by dry weight.

10. The method of any one of claims 7-9, wherein the first ply web forms a middle ply in the multi-ply paperboard.

11. The method of claim 10, wherein the second ply web forms a top ply in the multi-ply paperboard.

12. The method of claim 10 or 11, wherein a third ply web is further formed in the wire section of the paperboard machine, and wherein said third ply web forms a back ply in the multi-ply paperboard.

13. The method of claim 12, wherein water substantially free from bonding chemicals is also sprayed on a non-wetted surface of the second ply web or third ply web to obtain a second wetted surface in the wire section and merge the second wetted surface with a non-wetted surface of the second ply web or third ply web by couching.

14. The method of any one of the preceding claims, wherein Scott Bond strength according to Tappi T 569, of the multi-plied paperboard is at least 175 J/m^2, such as at least 190 J/m^2.

15. The method of any one of the preceding claims, wherein z-directional (ZD) tensile strength according to Tappi T 541 of the multi-plied paperboard is at least 300 kPa, such as at least 330 kPa.

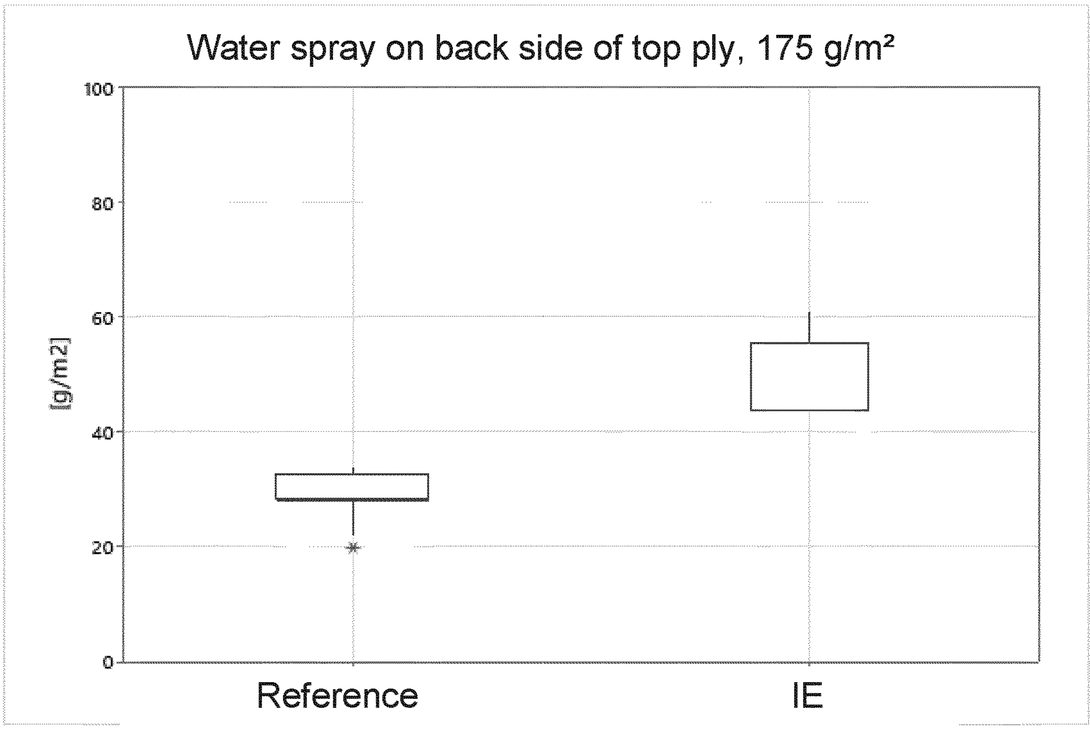
Water spray on back side of top ply, 175 g/m²
100
80
60
40
20
0
[g/m2]
Reference
IE

Fig. 1

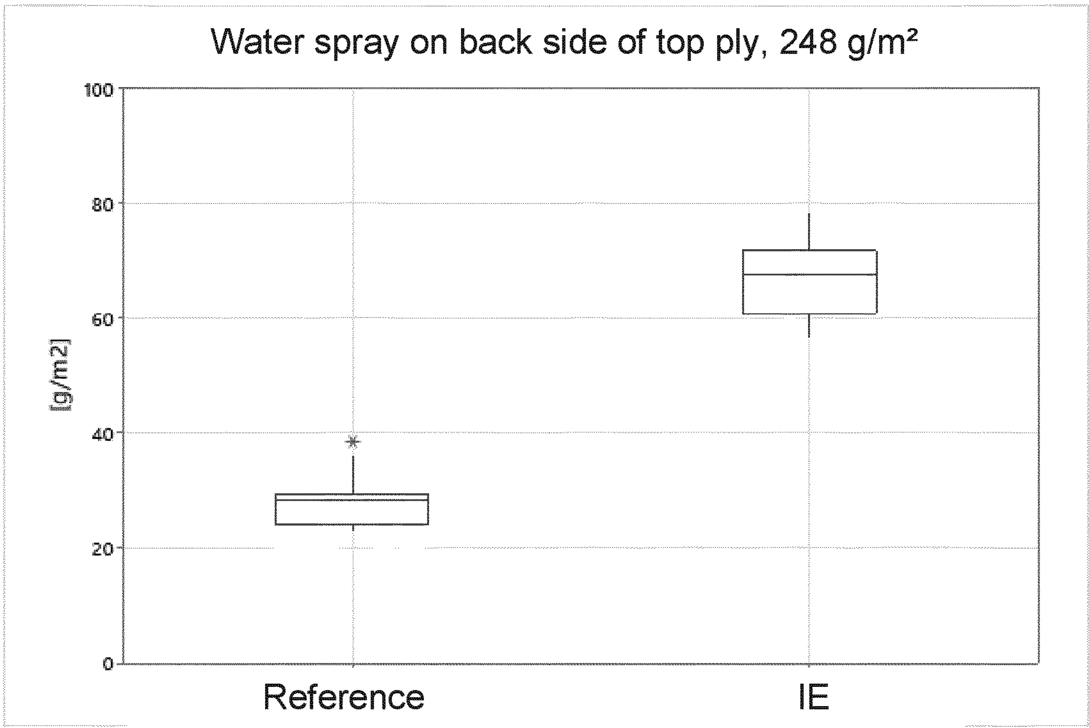
Water spray on back side of top ply, 248 g/m²
100
80
60
40
20
0
[g/m2]
Reference
IE

Fig. 2

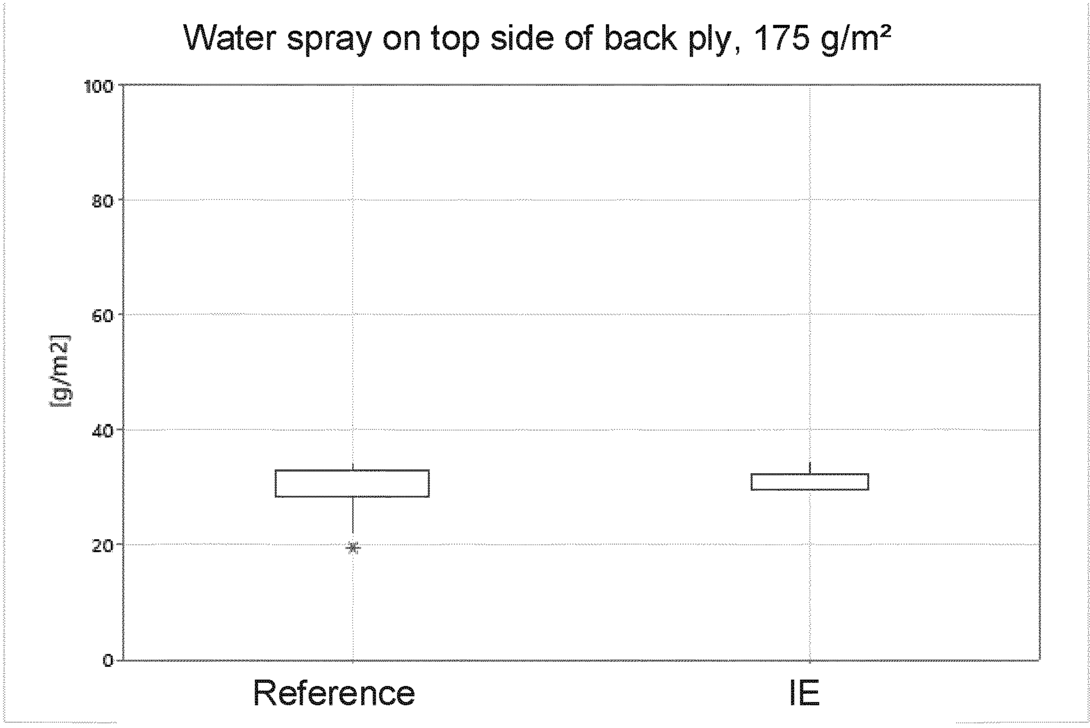
Water spray on top side of back ply, 175 g/m²
100
80
60
40
20
0
[g/m2]
Reference
IE

Fig. 3

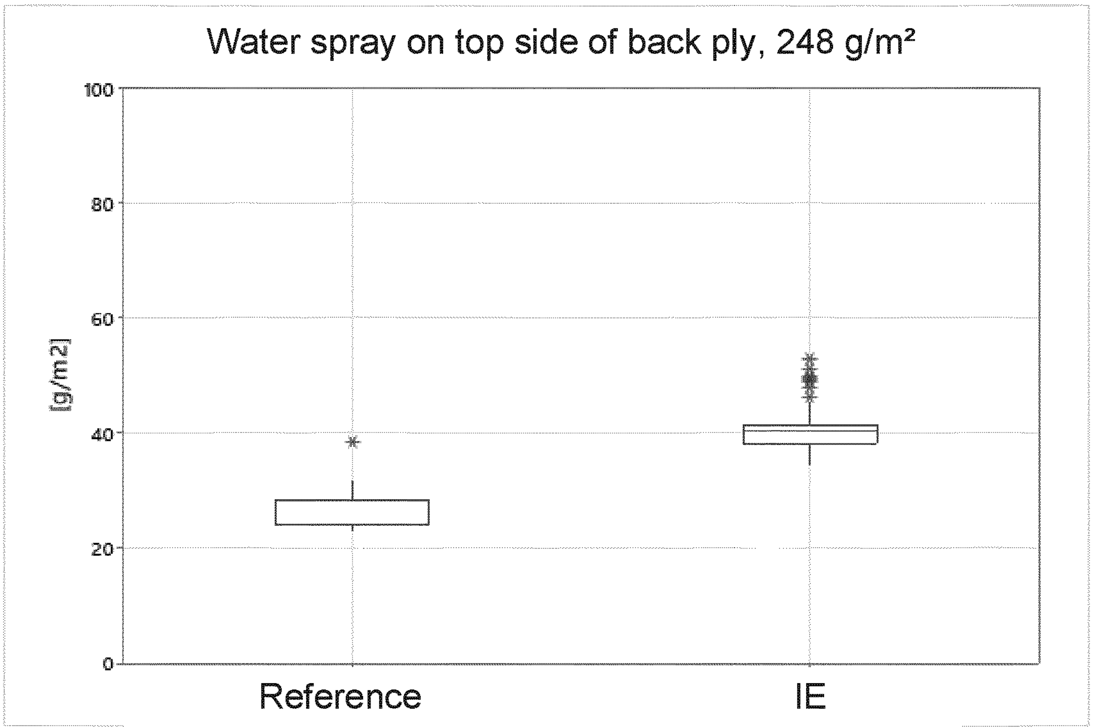
Water spray on top side of back ply, 248 g/m²
100
80
60
40
20
0
[g/m2]
Reference
IE

Fig. 4

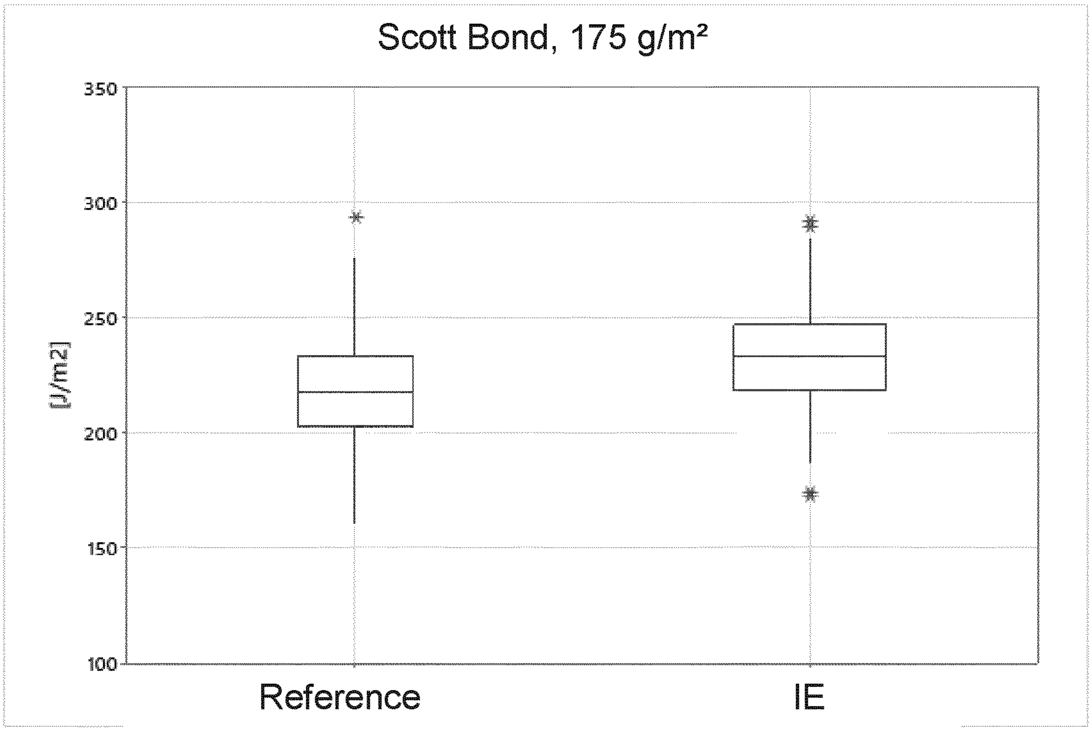
Scott Bond, 175 g/m²
350
300
250
200
150
100
[J/m2]
Reference
IE

Fig. 5

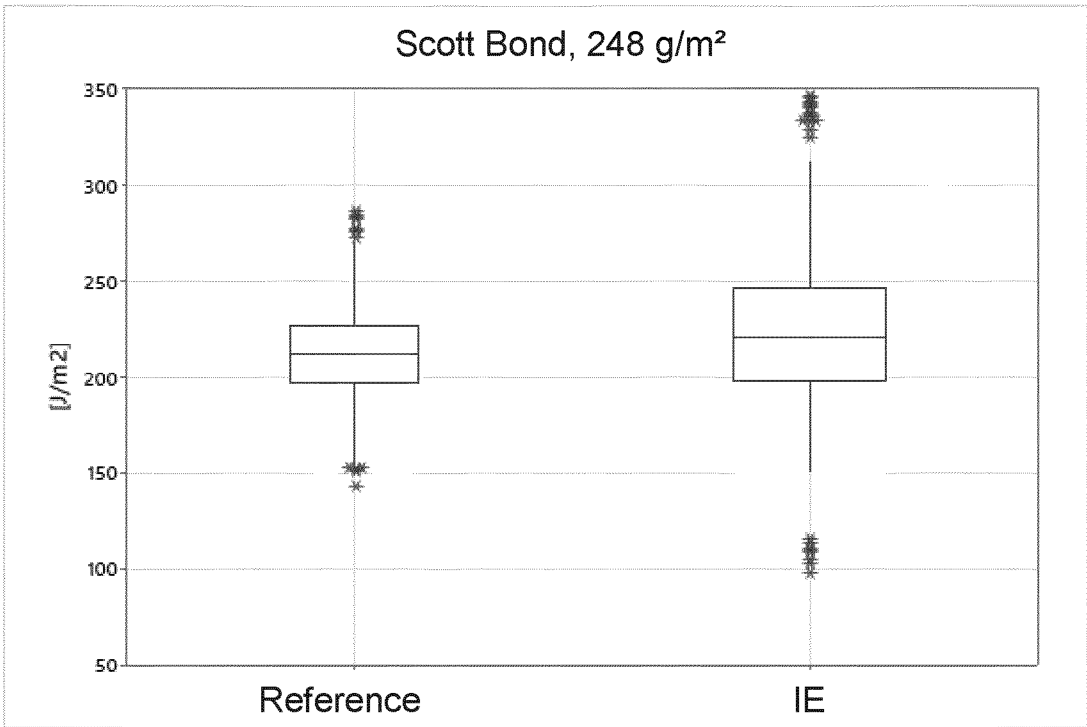
Scott Bond, 248 g/m²
350
300
250
200
150
100
50
[J/m2]
Reference
IE

Fig. 6


Z-directional tensile strength, 175 g/m²
[kPa]
550
500
450
400
350
300
250
Reference
IE

Fig. 7

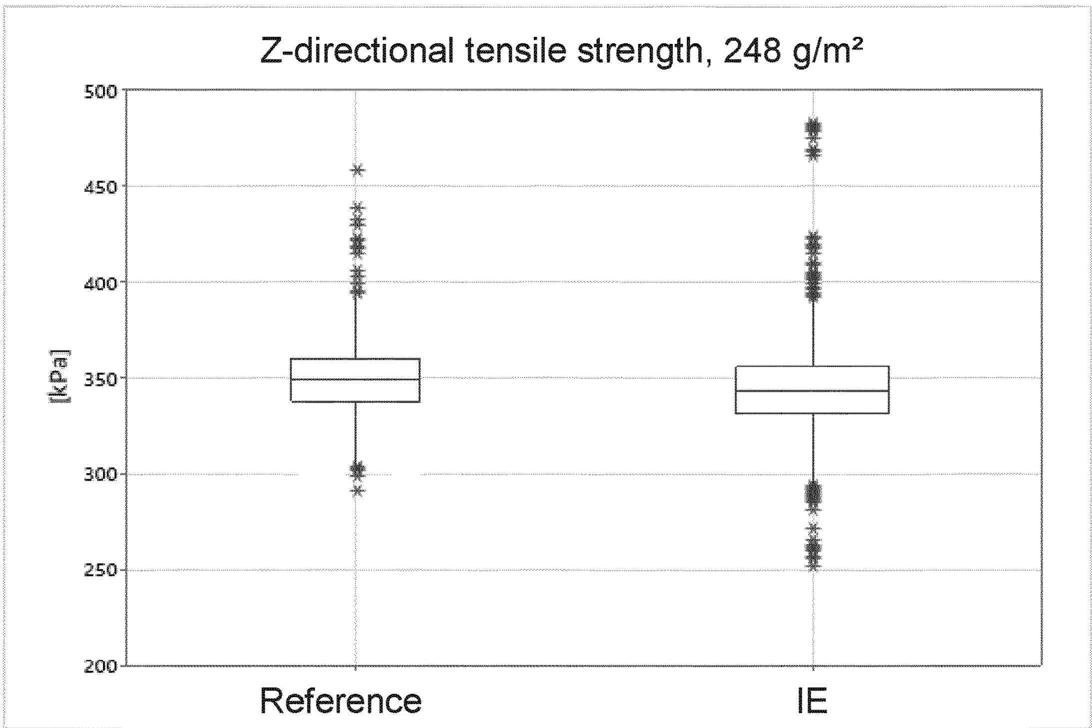
Z-directional tensile strength, 248 g/m²
[kPa]
500
450
400
350
300
250
200
Reference
IE

Fig. 8

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EUROPEAN SEARCH REPORT

Application Number
EP 23 21 8168

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Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
A	WO 2023/062557 A1 (STORA ENSO OYJ [FI]) 20 April 2023 (2023-04-20) * page 1, line 1 - line 6 * * page 4, line 5 - page 5, line 25 * * page 21, line 7 - line 13 * -----	1-15	INV. D21F11/04
A	WO 2011/056135 A1 (STORA ENSO OYJ [FI]; HEISKANEN ISTO [FI] ET AL.) 12 May 2011 (2011-05-12) * page 1, line 1 - line 9 * * page 4, line 1 - line 6 * * claims 1,2 * -----	1-15	
A	WO 2023/198916 A1 (BILLERUD AB PUBL [SE]) 19 October 2023 (2023-10-19) * paragraph [0001] * * paragraph [0038] - paragraph [0042] * -----	1-15	
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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	17 June 2024	Arndt, Markus

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CATEGORY OF CITED DOCUMENTS

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